Deng et al. Journal of Cardiovascular Magnetic Resonance 2015, 17(Suppl 1):Q11
http://www.jcmr-online.com/content/17/S1/Q11

Journal of Cardiovascular Magnetic Resonance

WALKING POSTER PRESENTATION Open Access

Reproducibility of phase-contrast MRI in the coronary artery: towards noninvasive pressure gradient measurement and quantification of fractional flow reserve

Zixin Deng[1,2*], Qi Yang[1], Xiaoming Bi[3], Zhaoyang Fan[1], Debiao Li[1,2]

From 18th Annual SCMR Scientific Sessions
Nice, France. 4-7 February 2015

Background

Fractional Flow Reserve (FFR) is an invasively determined index of the functional severity of an intermediate coronary stenosis by measuring the pressure drop across the lesion [1]. Noninvasive pressure gradient (ΔP) measurements using phase-contrast (PC)-MRI have been attempted in the aorta, carotid, and renal arteries [2-4]. The purpose of this study is to assess the reproducibility of PC-MRI and noninvasive ΔP calculations in the coronary artery, which is relevant for establishing the robustness of the noninvasive FFR technique.

Methods

2D PC-MRI was used to acquire two-cardiac-phase data at mid-diastole and end-expiration via ECG-triggering and navigator-gating on 3T MAGNETOM Verio (Siemens). K-space phase-encoding ordering is designed to allow off-line view sharing [5], which is applied in cases where the acquisition window exceeds the quiescent period (~100ms). The sequence measures the velocity field (v_x, v_y, v_z) of a single cross-section per acquisition and 4-5 consecutive slices were obtained in the proximal LAD. Reproducibility was assessed with two repeat scans on 4 healthy subjects. VENC ranged 30-45 cm/s for each flow encoding direction was determined from a VENC scout scan. The Navier-Stokes equations were used to derive ΔP [6]. In addition, a flow phantom (gadolinium-doped water flow at 300 mL/min in a silicone tubing of 4.8mm ID) with 40% stenosis (VENC=130z30xy cm/s) was likewise tested for reproducibility. Imaging parameters were: in-plane resolution = 0.58-0.67mm, slice thickness = 3.2 mm, flip angle = 15°, 65-71 ms/phase with the first phase strictly coinciding with the quiescent period, scan time = 1-3 min per slice. Absolute maximum and averaged velocities at each slice in all three directions and the ΔP between adjacent slices obtained from both scans were statistically compared via intra-class correlation (ICC).

Results

Volunteer studies: averaged maximum through-plane velocity over all healthy volunteers was 16.5±4.0 cm/s. A total of 19 slices were acquired from all subjects. For velocity measurements, excellent correlations were seen in the through-plane velocities (v_z), with ICCs of 0.93/0.96 and slightly lower in v_x and v_y with ICCs of 0.83/0.86 and 0.80/0.78 for cardiac phases 1 and 2, respectively. For ΔPs, ICC was 0.51 with an average of 0.1039±0.28 mmHg among all subjects. Phantom studies: stenosis with 40% narrowing showed excellent correlations in all velocity directions and ΔPs (table 1).

Conclusions

Our preliminary results suggest that the noninvasive quantification of flow velocities and ΔPs are reproducible in the coronary arteries, demonstrating the robustness and feasibility of 2D PC-MRI. Patient studies are underway to determine ΔP and FFR thresholds between healthy and patient populations. Further technical improvements are warranted to reduce noise and improve reproducibility.

Funding

N/A.

[1]Cedars Sinai Medical Center, Los Angeles, CA, USA
Full list of author information is available at the end of the article

Table 1 Intra-Class Correlation (ICC) between two scans.

	Velocity Encoding Direction	Averaged Velocity		Absolute Maximum Velocity		Pressure Gradient (ΔP)
		Phase 1	Phase 2	Phase 1	Phase 2	r = 0.508 p<0.05
Volunteers	Z	0.932	0.968	0.935	0.959	
	X	0.578	0.447	0.828	0.861	
	Y	0.931	0.918	0.804	0.779	
Phantom	Z	0.992		0.988		r = 0.768 p<0.05
	X	0.918		0.934		
	Y	0.979		0.969		

Authors' details
[1]Cedars Sinai Medical Center, Los Angeles, CA, USA. [2]Bioengineering, University of California, Los Angeles, Los Angeles, CA, USA. [3]R&D, Siemens Healthcare, Los Angeles, CA, USA.

Published: 3 February 2015

References

1. Pijls, *et al*: *NEJM* 1996.
2. Bock, *et al*: *MRM* 2011.
3. Lum, *et al*: *RY* 2007.
4. Bley, *et al*: *RY* 2011.
5. Deng, *et al*: *ISMRM* 2014.
6. Yang, *et al*: *MRM* 1996.

doi:10.1186/1532-429X-17-S1-Q11
Cite this article as: Deng *et al.*: Reproducibility of phase-contrast MRI in the coronary artery: towards noninvasive pressure gradient measurement and quantification of fractional flow reserve. *Journal of Cardiovascular Magnetic Resonance* 2015 **17**(Suppl 1):Q11.